

An Invited Paper for the 52nd IAF International Astronautical Congress:

The Shield Development Program for the Solar Probe Mission

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This mission to the solar corona requires a unique thermal shield that can insulate the spacecraft electronics from the large solar flux at the mission's destination to a perihelion radius of four solar radii. At this radius the solar flux is about 400 W/cm^2 (~ 3000 earth suns). A specific material for the shield (Carbon-Carbon) has been developed over a period of the last 15 years that will have the thermal optical properties to allow the shield to reradiate the absorbed thermal flux and reach a peak temperature at perihelion of "only" 2100K. In addition, the mass loss of the shield materials has been measured in an extensive test program to determine those fabrication techniques that would minimize this mass loss. This is important because the objectives of the mission include measuring the plasma environments at perihelion to determine the cause of solar coronal heating as well as the birth and acceleration of the solar wind. Excessive mass loss ($> 2.5 \text{ mg/sec}$) from the shield could cause contamination of these environments and jeopardize the success of the scientific measurements. Samples of this material were fabricated using various fabric constructs and densification techniques to understand the relationship between these fabrication characteristics and the resulting properties of the Carbon-Carbon that would be important to the thermal shield design. An extensive design and testing program has added new information to the technology data base for carbon-carbon shield materials at these extreme temperatures where this exciting scientific mission must operate.